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☐	L14	L13 and @ad<19971014	2
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... this capability and developed methods to **offload CPU** intensive tasks and ... TCP connection from the core stack to a **network interface card** (NIC). ...
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may be embedded in a **network interface card**,NIC,or host bus adapter,HBA. ... TOE not only **offload CPU** processing to increase application perfor- ...
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Method to offload a network stack patent
... that peripheral device manufacturers tried to do was to offload the entire TCP connection from the core stack to a **network interface card** (NIC). ...
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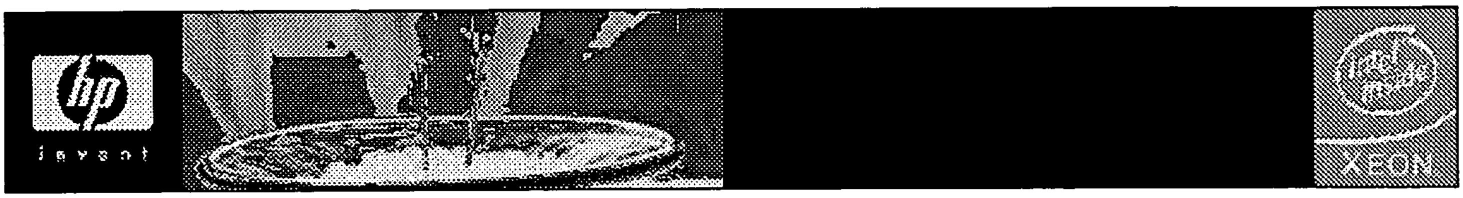

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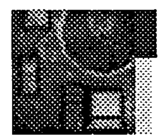

ARTICLE POSTED April 15th, 2002

Thanks to acceleration technologies, iSCSI is feasible

By Larry Boucher

iSCSI is a protocol that has attracted a great deal of attention in the storage industry. With iSCSI, users will be able to create SANs practically anywhere over standard Ethernet cabling — without requiring dedicated Fibre Channel networks to carry the data between the server and the storage devices. With iSCSI, remote mirroring and backup will become readily available because the distance limitations of Fibre Channel will be irrelevant in a world where data is transferred using standard TCP/IP and Ethernet for transport (see companion story on home page, "iSCSI developments bode well for commercial acceptance).

The emergence of Gigabit Ethernet, and the impending move toward 10 Gigabit Ethernet, will enable the transfer of data using iSCSI protocol at full device speeds. However, to perform these high-speed transfers, a new class of network device will be required.

Until recently, the **CPU** in a server or workstation was responsible for managing the TCP/IP processing necessary for sending and receiving data over a network, with a **network interface card** (**NIC**) providing the actual interface to the network. In the days when CPUs operated at considerably higher speeds than the network data flow, this was not a problem. However, with Gigabit Ethernet, processing of TCP/IP on the **host CPU** has often required as much as 100% of the processor's cycles.

With the addition of iSCSI processing on the **host CPU**, the result will be 100% **CPU** utilization — in effect, locking the computer for any other processes and significantly reducing network performance, because even

the fastest **CPU** will be unable to process TCP/IP and iSCSI at full wire speed.

Offloading server processing
The solution to this problem involves the use of a "TCP/IP **offload** engine" (TOE) that offloads some or all of the TCP/IP processing from the server. In essence, a TOE applies the task of TCP/IP processing to one or more chips that are optimized for this task.

With the addition of iSCSI, further processing is required. As with TCP/IP, the iSCSI processing can be done in software on the server **CPU**, or it can be offloaded to a device specially designed to perform the necessary processing. In all cases, however, to achieve the necessary performance for high-speed networking and/or storage processing, the most effective approach is to **offload** the processing from the **host CPU** to a specialized device.

Three iSCSI implementation approaches
Three basic approaches are being taken to implement iSCSI connectivity.

Standard NICs
Early implementations of iSCSI were proposed using standard Gigabit NICs that left the processing of iSCSI protocol to the **host CPU**. This approach may be the fastest to market because it simply incorporates standard components. But this simple approach is not viable because it requires considerable **CPU** resources. In most cases, the **host CPU** will run at 100% simply to process TCP/IP and iSCSI, and no resources will be available for other computing processes.

Even assuming 100% utilization of a Gigahertz processor, protocol processing with this approach will likely not keep up with wire-speed data transfer, especially when more than one network port or **NIC** is coupled to the **CPU**. Thus, although this approach supports Ethernet failover, load balancing and link aggregation, its poor performance makes it unacceptable for nearly all users.

Full-offload iSCSI HBAs
Taking a cue from the Fibre Channel world, a number of vendors are building iSCSI **host** bus adapters (HBAs). This new class of product uses a full-**offload** approach for iSCSI and TCP/IP protocol processing.

Full-**offload** adapters remove the entire TCP/IP stack from the **host CPU**. As a result, the **host** and network do not see the iSCSI adapters as **NIC** controllers. These cards are not designed to handle generalized networking tasks. For instance, the method for performing failover and link aggregation will not be able to follow a standard Ethernet implementation. Full-**offload** cards may use traditional storage failover facilities such as Active-Active designed for Fibre Channel.

For an iSCSI HBA, TCP/IP and iSCSI protocol processing may be performed on an embedded processor with either a standard Gigabit Ethernet controller or a specially designed application-specific integrated circuit (ASIC). Intel's recently announced PRO/1000 T IP Storage Adapter uses an Intel 80200 (XScale) processor with a standard GbE controller to perform the TCP/IP and iSCSI processing tasks.

Intel claims to have been able to transfer data over iSCSI at speeds ranging from 37.5M bps to 87.5M bps, with 3% to 5% **CPU** usage. However, without data on how the test was run, it is difficult to accurately compare this card's performance with that of other products.

Adaptec is attempting an ASIC implementation, supplementing the Intel 80200 processor with its Storage Protocol Accelerator (SPA) — AIC-7211 ASIC in the ASA-7211 iSCSI Adapter. Like the Intel card, the Adaptec iSCSI HBA uses an Xscale processor. At this time, however, the company has not provided any specifics relating to data throughput or the amount of **CPU** cycles required during data transmissions.

Data-path offload IS-NIC
The term "integrated storage **network interface card**" (IS-**NIC**) refers to an adapter that can be used as a network interface for moving Ethernet file data, as a storage interface for moving iSCSI block data, and as a dual-purpose card functioning as a **NIC** and as an iSCSI device simultaneously. This approach offers the advantages of both the iSCSI HBA and the standard **NIC**, while offering none of the disadvantages associated with isolating these functions.

Rather than move the entire protocol stack onto the adapter, an IS-**NIC** uses a technique called data-path **offload**; namely, data movement is performed in a custom-designed ASIC, and the TCP connection and error management is handled in **host** software. Although the **host CPU** may rarely have to control the data path, it is advantageous for the **host CPU** to be able to take control of the data path under certain conditions, such as error management.

Being able to control data flow enables the **host** computer to perform failover, load balancing and link aggregation using Ethernet standard protocols. If the **host CPU** or the network switch detects that one iSCSI card or link is handling a disproportionate amount of data, it can redistribute the data to other iSCSI cards.

The data-path **offload** approach eliminates the need to design a large, complex chip for rare error occurrences and enables the smallest footprint and the most power-efficient design for TCP/IP and iSCSI **offload**.

The Alacritech 1000x1 Single-Port Server and Storage Accelerator, which began shipping in October 2001, implements data-path **offload** for TCP/IP and iSCSI traffic. The data-path **offload** solution provides comparable or better performance and efficiency, compared with any Fibre Channel or iSCSI HBA. Alacritech recently reported successful wire-speed transfers of 219.64M bps with less than 8% **CPU** utilization for this Gigabit Ethernet IS-**NIC**. Testing was performed with a Nishan IP storage switch that converted iSCSI into Fibre Channel and moved the data to a Hitachi Data Systems SAN device.

An evolving standard
Although iSCSI adapters are currently available, the iSCSI specification has not yet been approved by the Internet Engineering Task Force (IETF). Approval is expected by mid-2002.

Because the specification may undergo additional modifications before an approved spec is agreed upon, it will be impossible to guarantee absolute adherence to the spec prior to its release. However, it is very safe to assume that vendors that are developing iSCSI cards are working hard to assure compatibility, irrespective of the final completion of the spec.

What the future holds
iSCSI is a logical step forward in the control of data devices. It eliminates the need for specialized HBAs in servers and workstations and allows block-level data to be transferred over a standard Ethernet network.

It will be interesting to see how the industry reacts to the various iSCSI alternatives — the processor-based iSCSI adapter that performs full **offload**, the ASIC-based card that performs full **offload**, and a programmable ASIC device that performs data-path **offload**. What should be clear, however, is that the industry is already responding with iSCSI devices, and that iSCSI is gaining momentum as a significant storage protocol.

In this article, we've looked at the three basic methods for implementing iSCSI as an initiator on the server side. Vendors are working on iSCSI-to-Fibre Channel gateways that provide an iSCSI interface to present Fibre Channel SANs. Although the number of iSCSI products currently available is small, it is clear that many vendors are hard at work developing highly compatible iSCSI products.

Larry Boucher is the Chairman and CEO of Alacritech, Inc.

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... and acknowledgement o partially **offload** keystroke processing ... Separation between the
host and onboard portions is ... The EXOS205 **Network Interface** Card for PC's is ...

comp.protocols.tcp-ip.ibmpc - May 12 1988, 8:34 pm by Chuck Kollars - 3 messages - 3 authors

multiple IP addrs on single net interface
... This **host** has a single **network interface**. ... HP gotcha #2: The code will almost certainly
not work on interfaces using checksum **offload** (eg. FDDI). ...
comp.unix.questions - Mar 11 1995, 5:14 am by Steinar Haug - 4 messages - 4 authors

Shared memory comm. on HP machines, possible?
... go to that hosts primary "real" **network interface** (such as lan0 ... not think that there
is checksum **offload**, and will ... If instead, you add some **host** routes for your ...
comp.parallel.pvm - Jun 23 1994, 7:52 pm by Rick Jones - 6 messages - 6 authors

DISPLAY=:0.0
... X calls go thru **network interface** if "**host**:0" is ... will go part-way into the **network interface's** _driver_ but ... to have a larger MTU and provides checksum **offload**. ...
comp.sys.hp.hpux - Nov 8 1996, 5:15 pm by Rick Jones - 19 messages - 14 authors

Fragen zu Protokollen
... Processing Environment" protocol, may be employed to **offload** Network and ... be erected
on an ARM LI - L II (**Network Interface** and **Host-Host** Layers) "foundation ...
de.comp.standards - Nov 15 1994, 6:41 pm by Kai Henningsen - 9 messages - 7 authors

Linux/tcpdump/NIC cards (traffic analysis)
... want a :"smarter" nic card that will **offload** some of the ... gives a breakdown of traffic
by **host** Let me ... does it use to put the **network interface** into promiscuous ...
comp.protocols.tcp-ip - Oct 5 1997, 7:24 am by Aaron Newsome - 7 messages - 7 authors

new Inmos Transputer (was Re: 88000 Question)
So you **offload** the protocol processing to a dedicated ... 100Mbps to the general purpose
host running Unix? ... because a transputer doesn't have a **network interface**. ...
comp.sys.next.misc - Jul 29 1991, 2:56 am by Scott Hess - 57 messages - 29 authors

Introduction to TCP/IP Administration by Chuck Hendrick
... the machine has more than one **network interface**, you must ... point lines or switched

lines directly to each **host**. ... It often makes sense to **offload** the routing and ...
comp.os.ms-windows.networking.tcp-ip - Dec 1 1995, 5:37 am by Greg E Hersh - 1 message - 1 author

Embedded Processor and Microcontroller primer and FAQ
... a dedicated [co]processor to **offload** some of ... for another keystroke, or information
from the **host**. ... multi-master, multi-slave **network interface** with collision ...
comp.robotics.misc - Oct 1 1996, 7:23 pm by Russ Hersch - 1 message - 1 author

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